

Introduction

Project Objectives

The goal of the TEEM project is to provide a suite of sales dynamics models to support techno-economic evaluation of VTO technologies. Understanding technology impacts requires structural understanding of market response. Modeling endogenous adoption is a critical linkage between technology R&D needs and impacts. By applying established decision science theories, sales dynamics models are a critical tool for analyzing VTO technology impact and generating insights for technology R&D activities.

The development objectives of these models include the following:

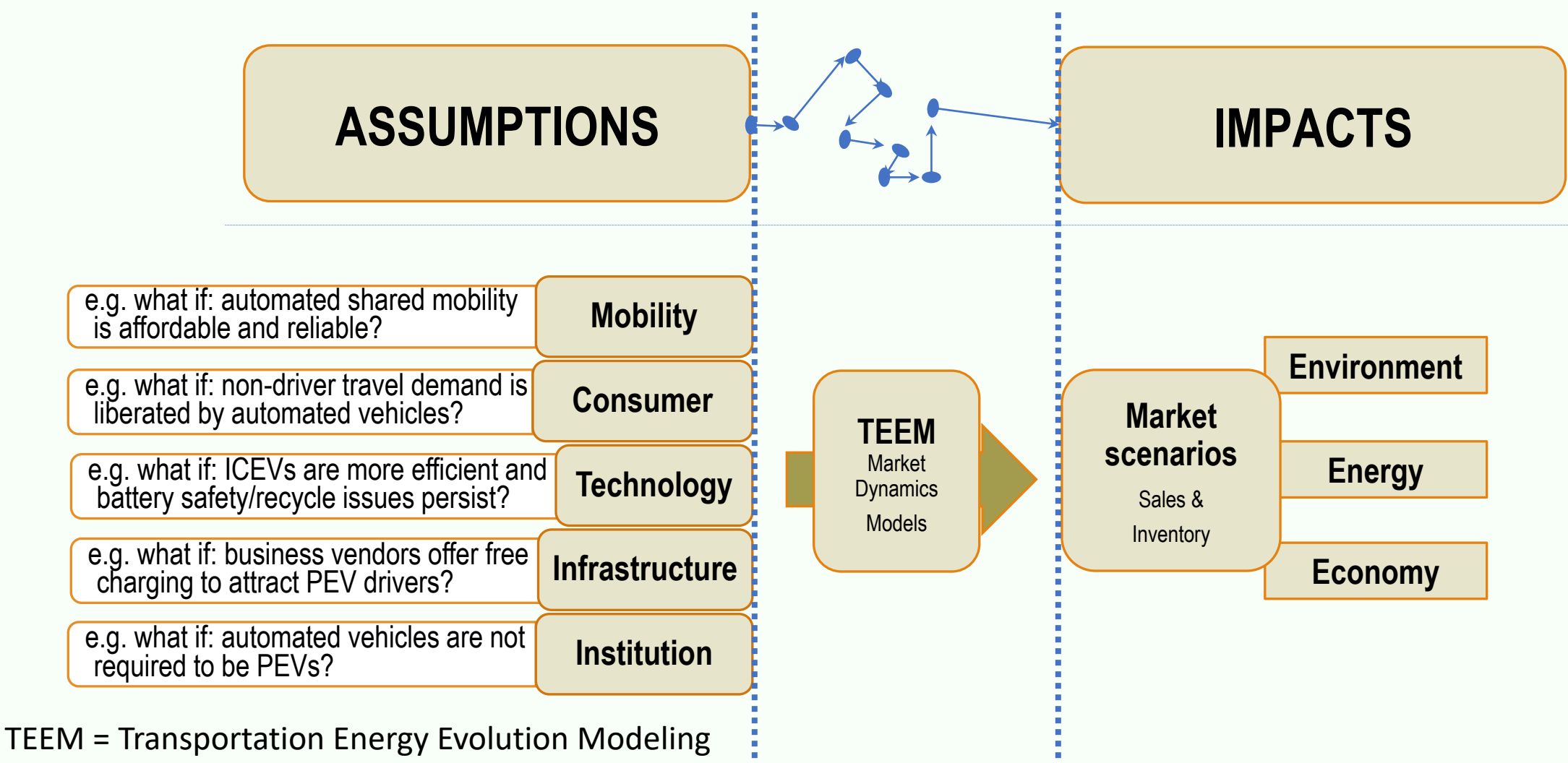
- **Technology scope** of the U.S. LDV/non-LDV/private/commercial-vehicle technologies, shared mobility and connected and automated vehicles.
- **Relevance** to VTO/DOE research.
- **Comprehensiveness** in considering behavior, technology, and infrastructure factors.
- **User-friendliness** of the models for third-party users.
- **Credibility** of models established by systems dynamics validation and peer-reviewed publications.
- **Collaboration** through use of existing models and engagement with academics and industry.

FY22 Milestones

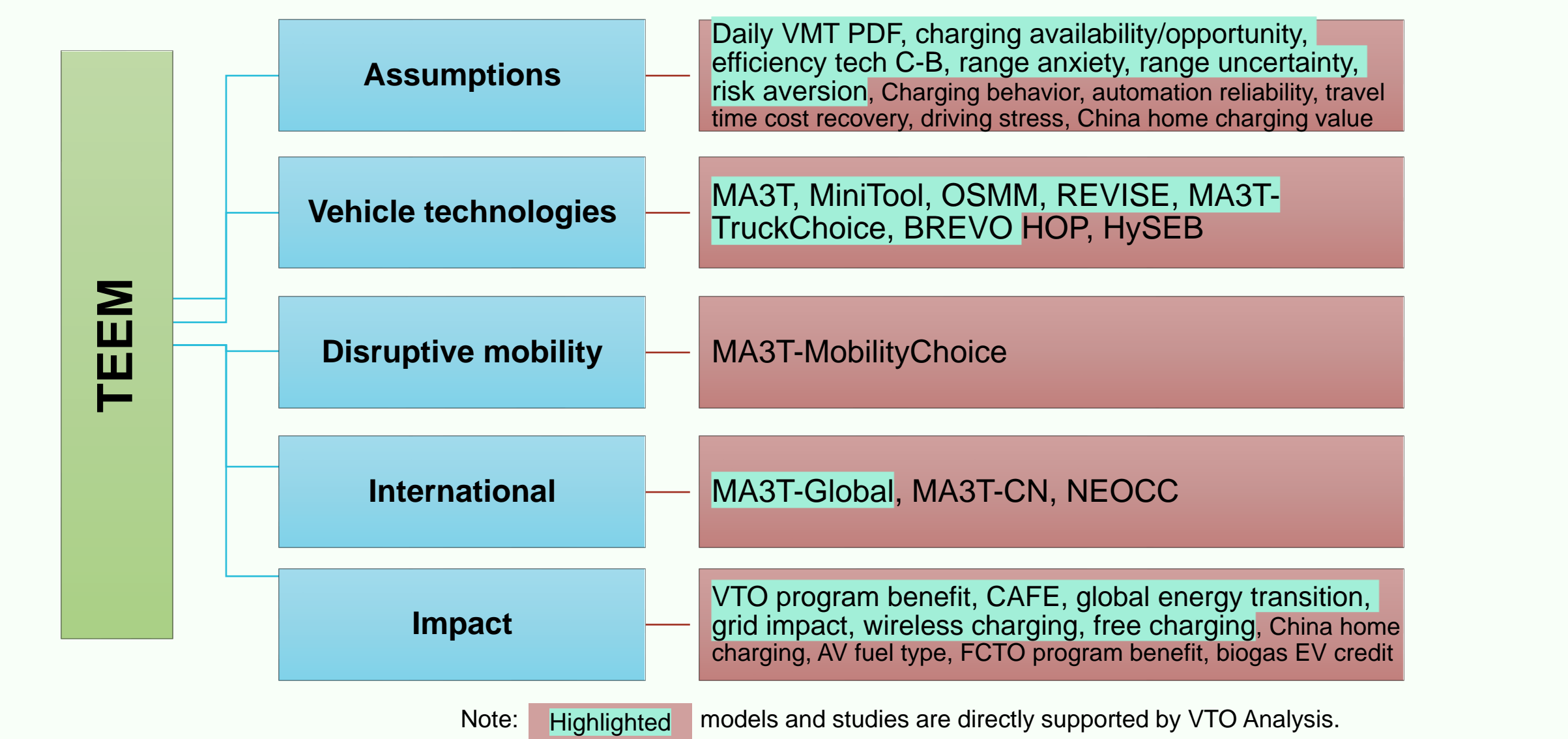
Milestone Description	Month/Year	Status
MA3T-TruckChoice progress report: describing model development and scenario results	12/31/2021	Complete
MA3T progress report on net-zero strategy analysis for the light-duty vehicle market	03/31/2022	Complete
Improving effectiveness and equity of fuel economy regulations by recognizing vehicle usage heterogeneity in MA3T	06/30/2022	On schedule
TEEM models progress report including work on MA3T, MA3T-TruckChoice and MA3T-used	09/30/2022	On schedule

Approach

Quantify/simulate assumption-impact linkages with systems dynamics models



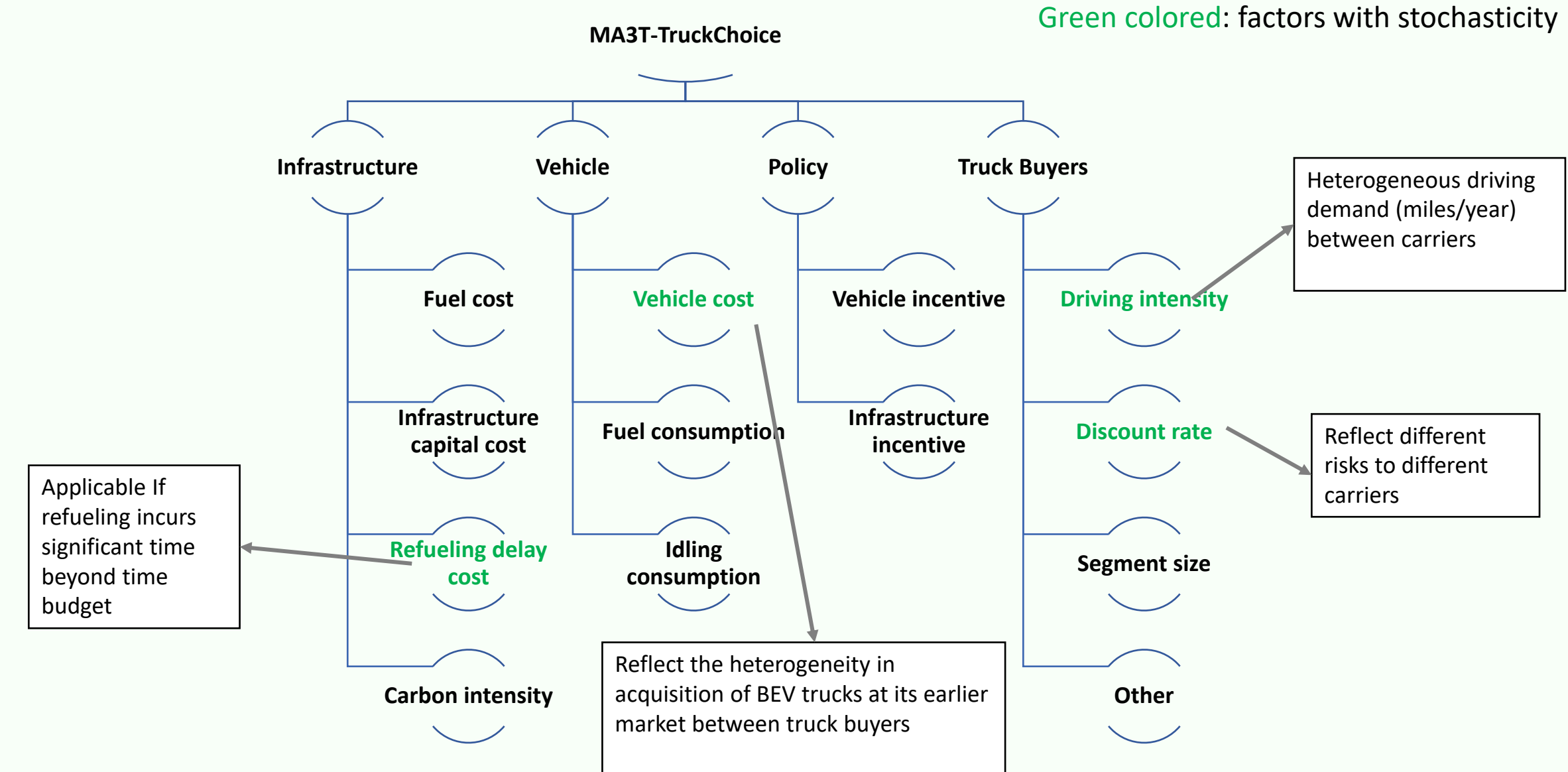
Organization of TEEM research activities



For example, consider a new study of cost-benefit of charging infrastructure investment (**impact**). If the technology scope is focused on traditional **vehicle technologies**, MA3T can be used. If **disruptive mobility** technologies such as AV are of interest, MA3T-MobilityChoice can be used. If **international** scope is of interest, MA3T-Global can be used. In all cases, the **assumptions** on charging availability/opportunity linkage and daily VMT PDF should be formulated, analyzed and validated (the TEEM group has published papers on these issues).

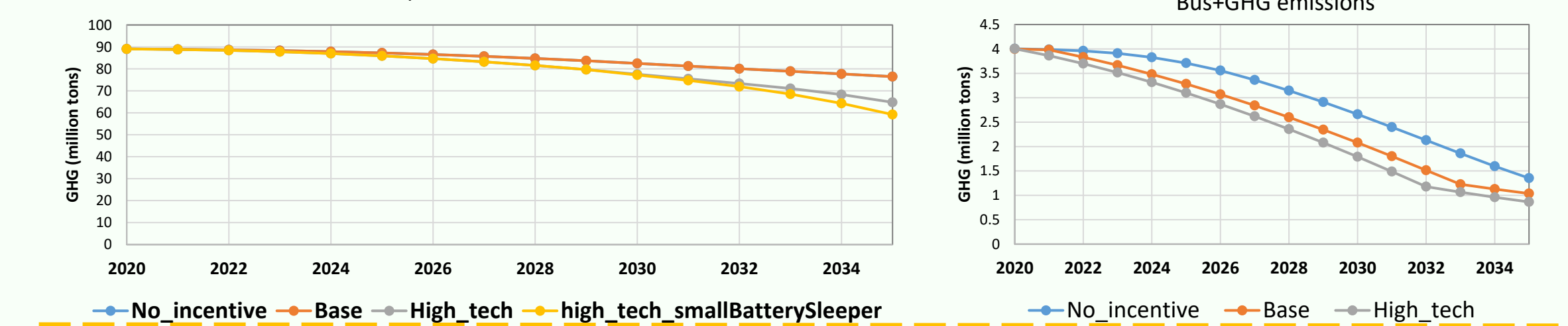
Truck-Choice Model

MA3T-TruckChoice: Model Structure



Current Scopes of Truck-Choice:

- Three segments: Day-cab, sleeper, and bus.
- Multi-year evolution of sales, stocks, energy use, incentive value, and carbon emissions



Key Messages From Results of MA3T-TruckChoice Model:

- Purchase incentives are only effective when the total cost of ownership (TCO) of zero-emission vehicle (ZEV) is close enough to the diesel baseline.
- Due to battery cost reduction and improved understanding of truck electrification, it is time to consider how to design purchase incentives for ZEV trucks.
- This study quantified the impacts of different incentive levels on adoption, GHG reduction, fiscal burden, and mitigation efficiency (i.e., \$/tonCO2 reduced).
- It is found that purchase incentives alone won't mitigate GHG efficiently; but combining their external effect in stimulating investment and innovation, purchase incentives can be optimized to be an efficient GHG mitigation policy, similar to light-duty PEV purchase incentives.

Improve Equity of FE Regulations with SAFs

Background and Motivation

- A factor not considered by current fuel economy (FE) regulations is that large vehicles are driven more.
- Vehicle usage and ownership correlate with demographic attributes (e.g., income), pointing to potential transportation energy equity concerns.

Objectives

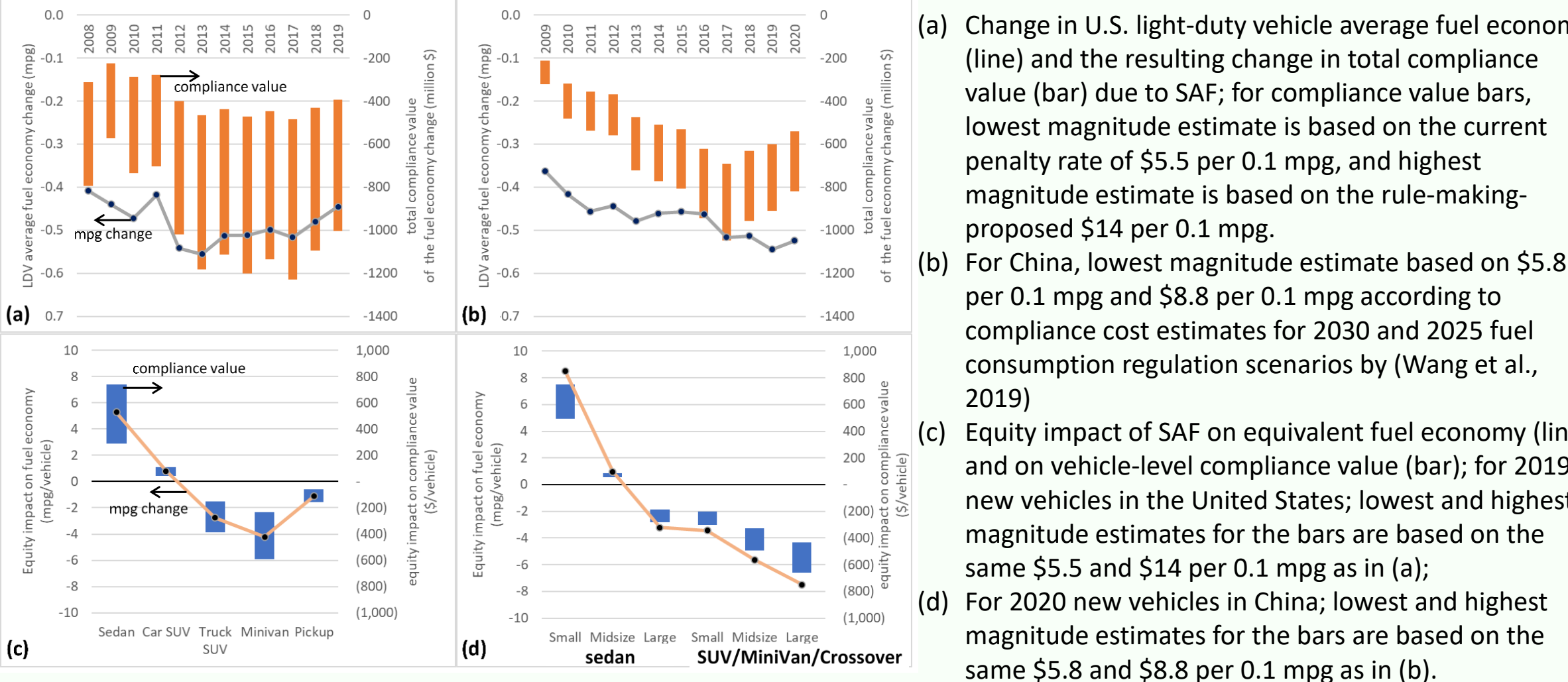
- To show evidence that, in the U.S., large vehicles are driven more than represented in regulations and are more commonly owned by high-income households.
- To propose the Sales Adjustment Factor (SAF), to correct this usage under-representation in the fuel economy regulations.

Method

- For a given model year, the usage-weighted corporate average fuel economy $CAFE_{usage}$ is a function of fuel consumption rate (f_i , amount of fuel per unit of distance), annual driving distance (d_i), vehicle lifetime (l_i), and sales n_i , for vehicle model or type, as shown:

$$CAFE_{usage} = \frac{\sum_i (n_i l_i d_i f_i)}{\sum_i (n_i l_i d_i)}, \quad k_i = \frac{l_i d_i}{l_i d_i} = SAF_i$$

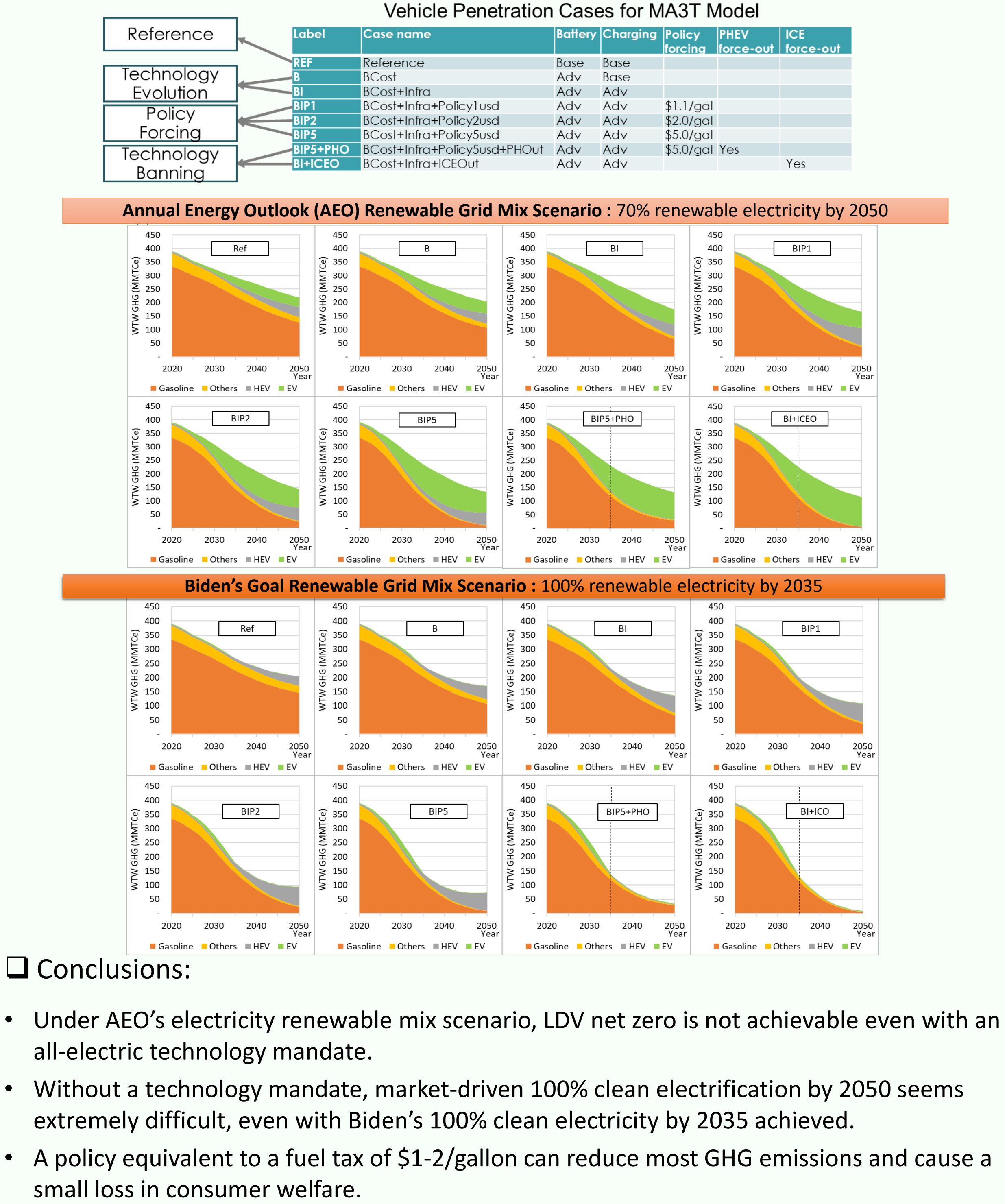
SAF Impacts on Effectiveness and equity of fuel economy regulations.



Decarbonization Strategy in the U.S. LDV Market

Vehicle Electrification toward Net Zero -- What's Lacking?

We used the discrete choice model (MA3T) + lifecycle model (VISION) + fleet accounting model (GREET) to quantify the GHG and consumer welfare impacts under different grid mix scenarios combining with multiple vehicle penetration cases for the U.S.

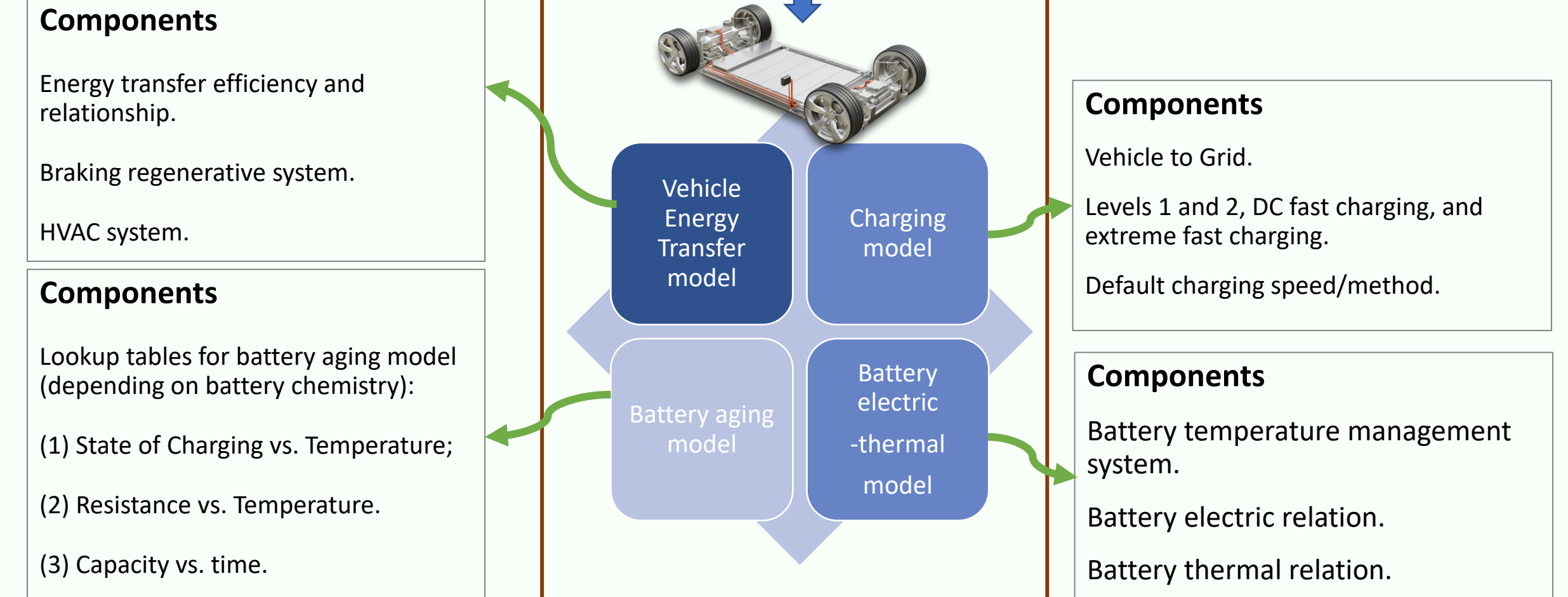


BREVO: Charging Impacts on Battery Degradation

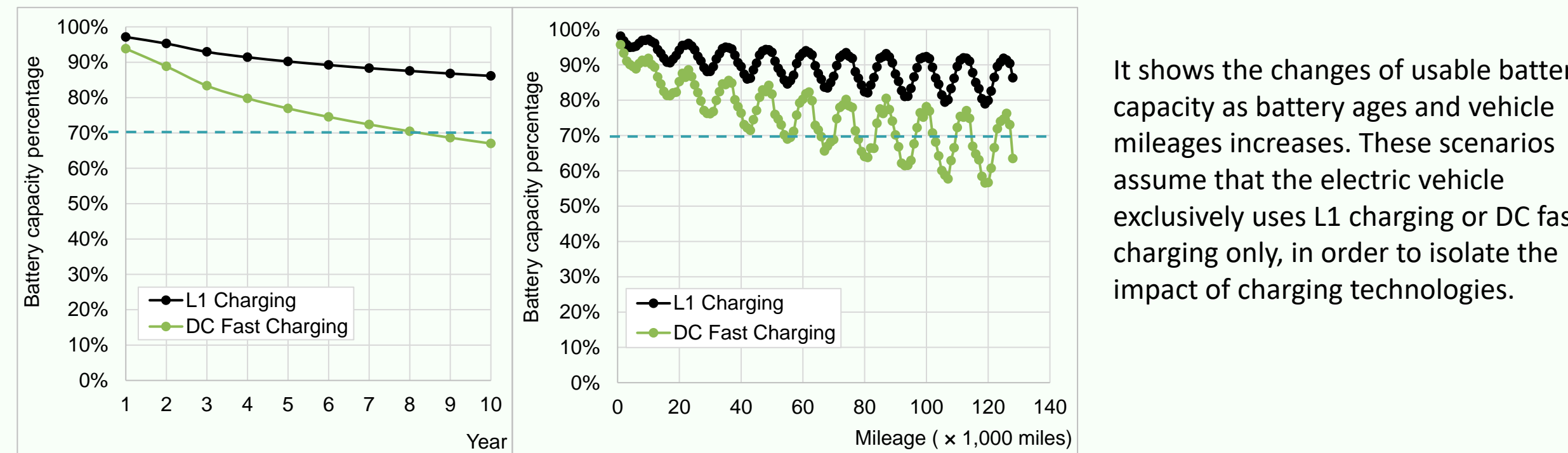
BREVO: Battery Run-down under Electric Vehicle Operation Model

This model aims to quantify real-world battery lifetime by linking lab battery degradation relationships with driver behaviors (including charging behavior and charger type). It can also quickly evaluate the potential battery cost and electric vehicle TCO under multiple on-road driving scenarios.

Modeling Framework



Simulation Results: Impacts of charging on battery degradation



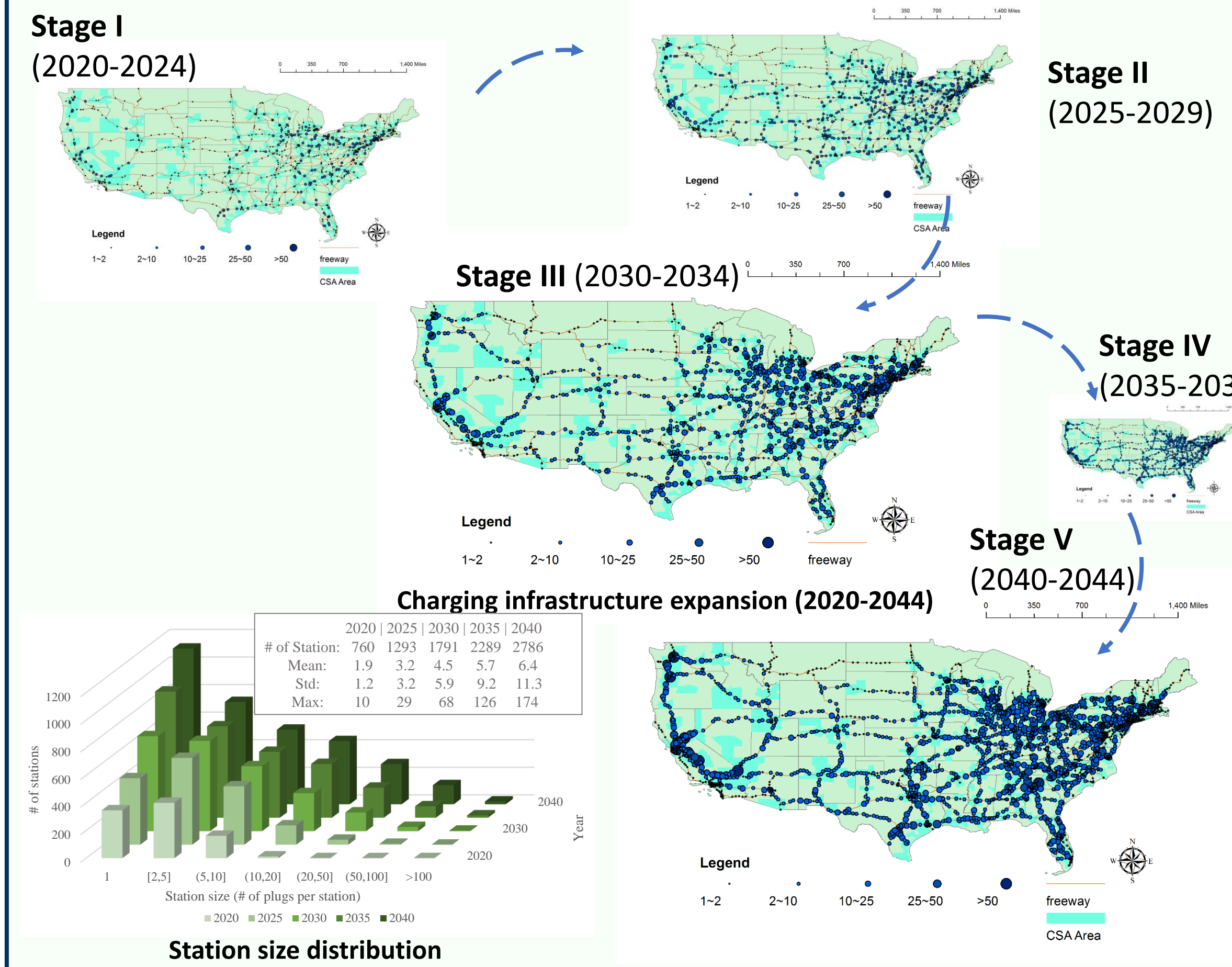
It shows the changes of usable battery capacity as battery ages and vehicle mileages increases. These scenarios assume that the electric vehicle exclusively uses L1 charging or DC fast charging only, in order to isolate the impact of charging technologies.

REVISE-II: Corridor Charging Infrastructure

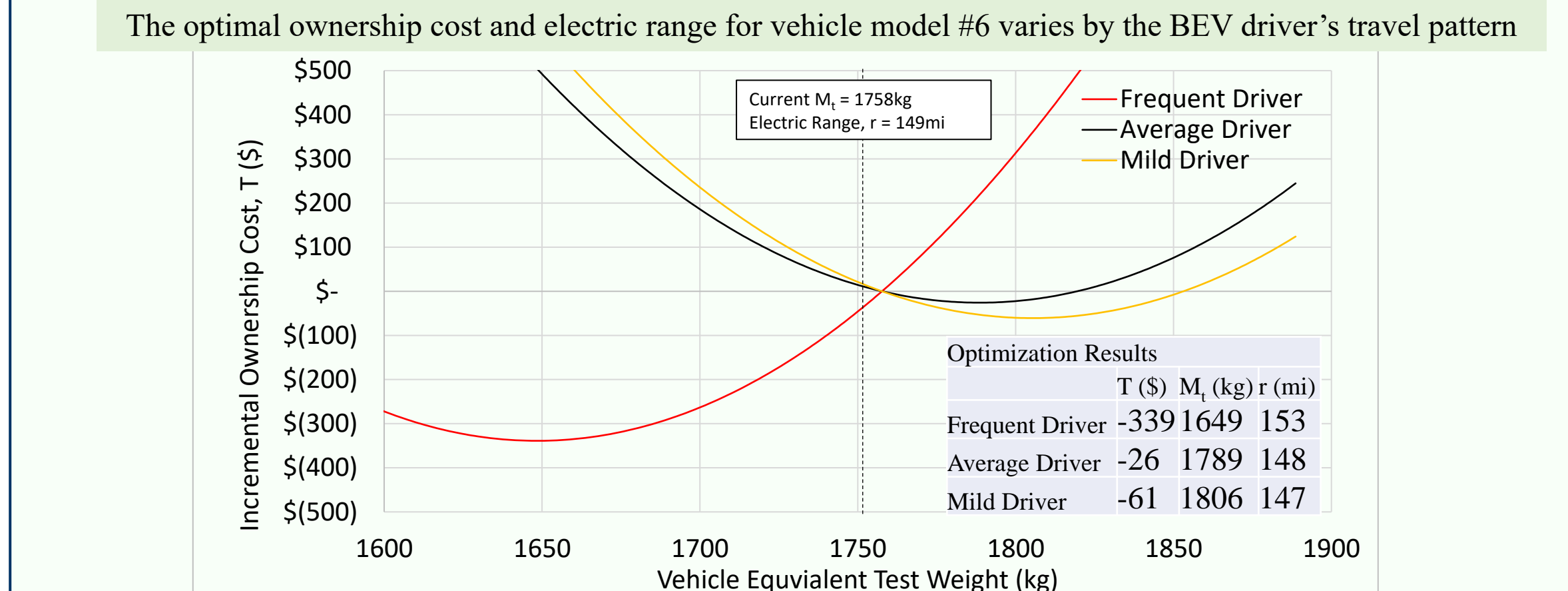
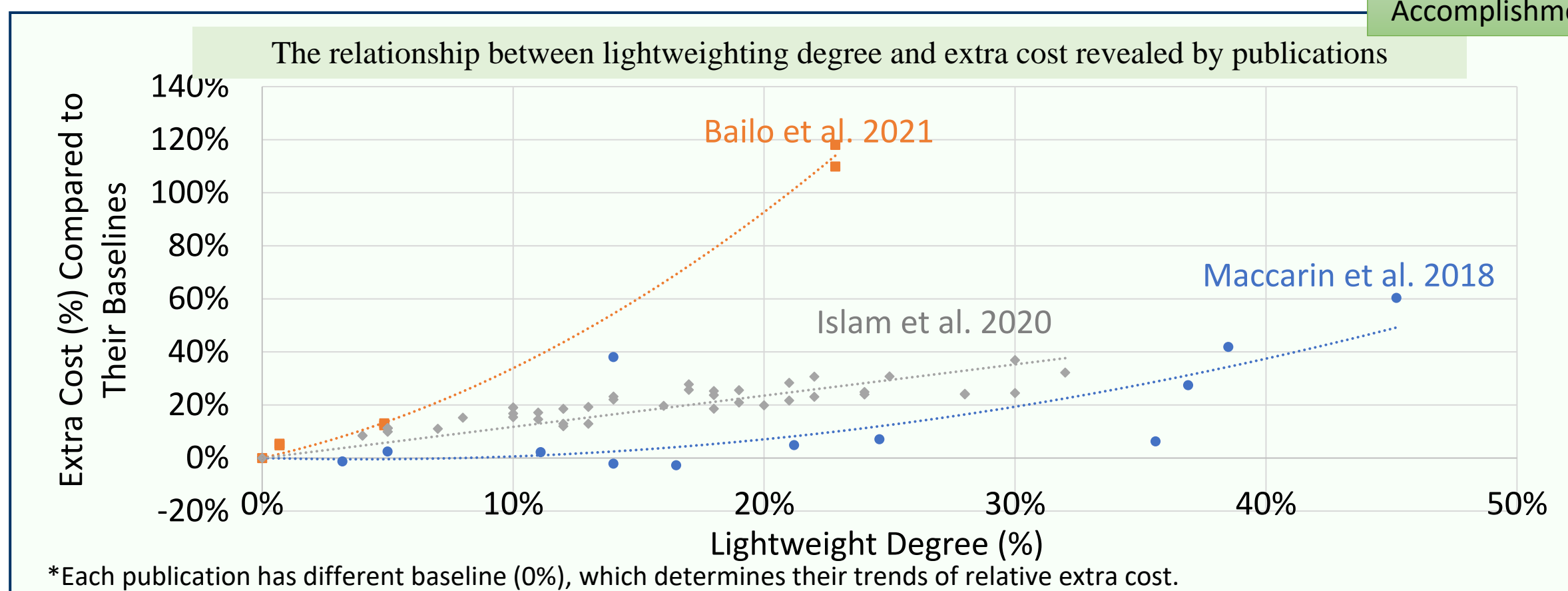
Regional Electric Vehicle Infrastructure Strategic Evolution 2.0 (REVISE-II)

Updated REVISE-II Model Summary

- **Consideration of traveler heterogeneity:** This model considers additional demographic dimension with segmentations of heterogeneous travelers to model charging infrastructure requirements.
- **Quantification of inconvenience cost:** It seminally formulates the inconvenience cost function that sets up the linkage between the effectiveness of planning out EV infrastructure and exogenous technology, policy, and traveler factors.
- **Modeling impacts of inter-regional traffic flows at the national scale:** REVISE-II targets at the full-scale inter-regional charging infrastructure systems in the U.S. Users could evaluate the inter-regional charging infrastructure requirements and their comparison with the conventional regional level analyses.



Determine Optimal Range with BEV Lightweight



Summary of Accomplishments

- The ORNL TEEM project includes several models useful for analysis of transportation energy issues: MA3T, MA3T-TruckChoice, MA3T-Used, TransitMo, REVISE, BREVO, MA3T-MobilityChoice, etc.
- The TEEM team has published 6 journal articles during FY21-22. Manuscripts are available for download at TEEM.ORN.LGOV